

ABUNDANCE AND DISTRIBUTION OF TUNICATES ON THE NORTHERN CONTINENTAL SLOPE OF THE GULF OF MEXICO

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ABSTRACT

Eleven species were collected along three north-south transects between 350 m and 2,850 m depth. All are typical abyssal species. There is a new species, the others being known from several deep basins in the southern Atlantic. Many immature specimens were collected. The ascidian density is the highest known in the deep-sea. The northern slope of the Gulf of Mexico represents the shallowest stations in the bathymetric distribution of all species. According to the water masses studied there and the faunal affinities, the origin of this ascidian fauna is the South Atlantic.

A deep sea zoological collecting program along the continental slope of the northern Gulf of Mexico resulted in regular sampling along three transects (W, C, E; Fig. 1). These collections were made between 350 m and 2,850 m depth. Another series of 12 samples (WC) took place between the west and central transects from 330 m to 1,250 m depth. Two kinds of collecting devices were used: trawls and box-corers, the latter of 475 cm² and 569 cm². Of the 129 tunicates collected, only one was taken by the trawl. This result is surprising particularly when compared with other samplings in the Atlantic, but it may be due to the particularly small size of the ascidians in the Gulf of Mexico.

All the species listed here, except one, were recently described or figured so we do not give full taxonomic descriptions, but sometimes additional details or comments. Eleven species have been identified; one new species belongs to the deep-sea genus *Bathystyeloides* Seeliger, 1907. Many specimens were immature and thus impossible to identify although these were taken into account in the density evaluations.

There is no taxonomic relationship among the deep ascidian fauna and the animals of the coastal area in the Gulf of Mexico. It is confirmed here that even the bathyal forms are totally isolated from those of the coastal water in the other parts of the Atlantic.

The small number of aplousobranchs and phlebobranchs compared to stolidobranchs appears to be a characteristic of deep-sea tunicates world wide.

Order APLOUSOBRANCHIATA

Family Polyclinidae

Synoicum daucum Monniot and Monniot, 1974

Stations.—WC6: 27°42.7'N, 91°33.9'W, 554 m, 1 specimen; E2: 28°02.7'N, 85°40.1'W, 624 m, 1 specimen; E3: 28°15.8'N, 86°37.0'W, 848 m, 1 specimen.

This species was previously known only from the type locality (21°59'S, 09°01'E, 4,180 m) in the extreme north of the Cape Basin. The shape of the colony (Fig. 2A) and the zooids do not differ, notwithstanding the much shallower depth of the present material and the geographical separation.

Order PHLEBOBRANCHIATA

Family Cionidae

This shallow water family is not well diversified and very few solitary or colonial species are described. On the northern slope of the Gulf of Mexico, two species

of this family are present, one solitary and one compound. These are common representatives of the deep-sea acidian fauna.

Araneum sigma Monniot and Monniot, 1973

Station.—C4: 27°28.4'N, 89°46.9'W, 1,386 m, 1 specimen.

A. sigma is a fragile solitary species common from 1,000 m to 5,000 m in the northeast Atlantic (Monniot and Monniot, 1985a). It also has been found west of the Azores and in the Surinam (Monniot and Monniot, 1976b) and Argentina basins (Monniot and Monniot, 1976a). Its presence is not surprising here. For the habitus see Monniot and Monniot (1973, fig. 18b).

Pseudodiazona abyssa Monniot and Monniot, 1974

Stations.—C4: 27°28.03'N, 89°47.1'W, 1,444 m, 1 specimen; C9: 27°29.2'N, 89°47.8'W, 1,390 m, 1 specimen.

This colonial form has a rather strong tunic but the small number of zooids are mostly cut in pieces. In one specimen (Fig. 2B) gonads were present. The species has a wide distribution in the eastern Atlantic from the Bay of Biscay to the Angola basin (Monniot and Monniot, 1976c). It is known from the west of the Azores and in the Argentina basin from 1,000 m to 5,000 m depth. This species is also present in the Indian Ocean near Mayotte where it is known only from 450 m (Monniot and Monniot, 1985b).

Order STOLIDOBRANCHIATA

Family Styelidae

Dicarpa simplex Millar, 1955

Stations.—W2: 27°24.9'N, 93°20.4'W, 603 m, 2 specimens in 2 cores; WC2: 27°43.91'N, 92°30.24'W, 550 m, 1 specimen; WC3: 27°35.56'N, 92°21.70'W, 750 m, 1 specimen; WC9: 27°41.62'N, 91°17.89'W, 753 m, 1 specimen; WC11: 27°23.50'N, 92°44.25'W, 1,222 m, 2 specimens in 2 cores; C3: 27°49.2'N, 90°07.1'W, 834 m, 4 specimens in 3 cores; C4: 27°28.4'N, 89°46.8'W, 1,390 m, 11 specimens in 6 cores; C9: 27°29.19'N, 89°47.84'W, 1,390 m, 2 specimens in 2 cores; C11: 27°14.72'N, 89°41.5'W, 2,124 m, 1 specimen; E2: 28°16.7'N, 86°15.1'W, 625 m, 8 specimens in 7 cores; E3: 28°09.5'N, 86°26.2'W, 847 m, 24 specimens in 18 cores.

D. simplex is a small triangular styelid on a long stem (photograph in Monniot and Monniot, 1978 fig. 5F). It has been collected many times. Described the first time from west of the Azores between 4,500 m and 4,600 m depth, it is especially abundant in the Angola and Guinea basins between 3,575 m and 5,125 m (Monniot and Monniot, 1974). Millar (1969) found it in the Pacific Ocean off Panama 9°23'N, 89°33'W at 3,570 m; it had not previously been collected in the western Atlantic.

Polycarpa pseudoalbatrossi Monniot and Monniot, 1968

Stations.—WC3: 27°35.61'N, 92°21.76'W, 750 m, 1 specimen; WC9: 27°41.53'N, 91°17.85'W, 761 m, 1 specimen; WC10: 27°45.29'N, 90°47.63'W, 748 m, 63 specimens in 1 core.

The species occurs in the north Atlantic Ocean in the Angola and Guinea basins and in the Argentina basin from 1,600 m to 4,700 m (Monniot and Monniot, 1985a). In the Gulf of Mexico, *P. pseudoalbatrossi* is found in shallower water less than 1,000 m.

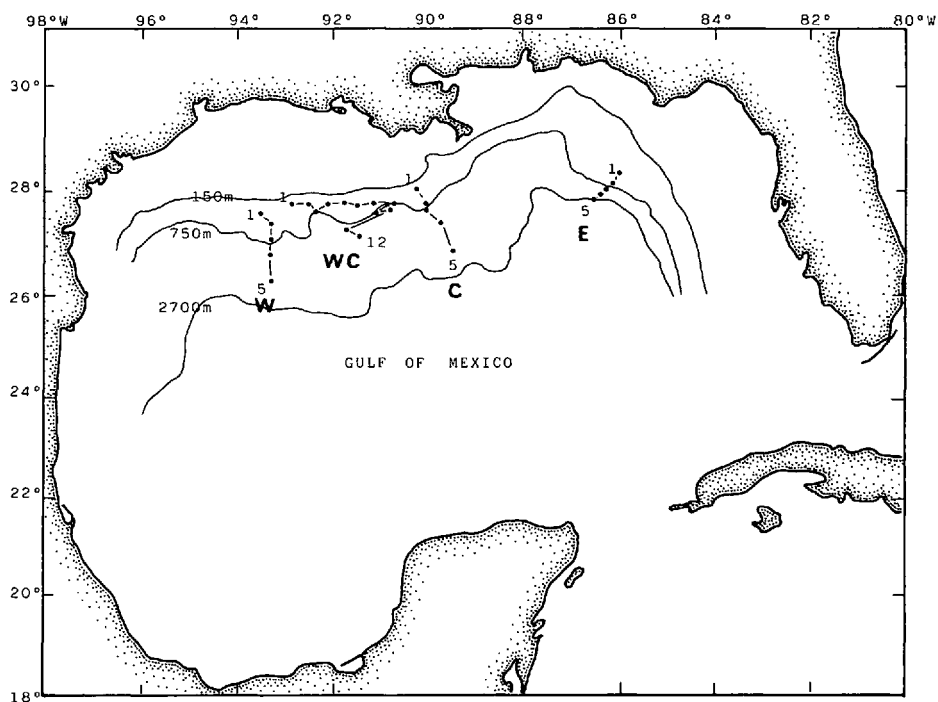


Figure 1. Location of transects on the northern Gulf of Mexico continental slope.

Bathystyeloides enderbyanus (Michaelsen, 1904)

Station.—C5: 26°56.5'N, 89°33.2'W, 2,400 m, 1 specimen in trawl.

B. enderbyanus is found throughout the Atlantic, Indian (Monniot and Monniot, 1977a, 1977b) and the South Pacific (Millar, 1959) Oceans between 2,000 m and 6,000 m depth.

Bathystyeloides mexicanus new species

Stations.—WC11: 27°23.55'N, 92°44.71'W, 1 specimen; C4: 27°28.03'N, 89°47.08'W, 1,444 m, 3 specimens in 3 cores. Holotype in USNM, n° 17488 paratype in MNHN Paris, n°S1, BatB, 32; C9: 27°29.22'N, 89°47.83'W, 1,390 m, 1 specimen; E3: 28°09.6'N, 86°25.0'W, 845 m, 3 specimens in 2 cores; E4: 28°04.1'N, 86°34.4'W, 1,335 m, 2 specimens in 1 core.

Diagnosis.—This species is very small and spherical with a maximum diameter of 1 mm. There is generally a long, single rhizoid (two in one specimen, Fig. 3A), opposite the apertures. The tunic is thin, naked, with very small granulations; occasional particles adhere to them (Fig. 3A). The oral aperture has four short lobes, the cloacal one only two ventral lobes. The body wall is thin and does not enter the peduncle as in *Dicarpa simplex*. This character helps to separate the two species before dissection as they are otherwise very similar in general appearance and size. There are about 12 irregular tentacles arranged in a single circle, those dorsally located being shorter (Fig. 3B). The peripharyngeal band forms a V in which the round dorsal tubercle opens. The branchial sac (Fig. 3C) has only protostigmata, up to 10 on each side. There are three longitudinal bars on each side. The dorsal lamina is displaced on the left side, its plain membrane has a smooth edge.

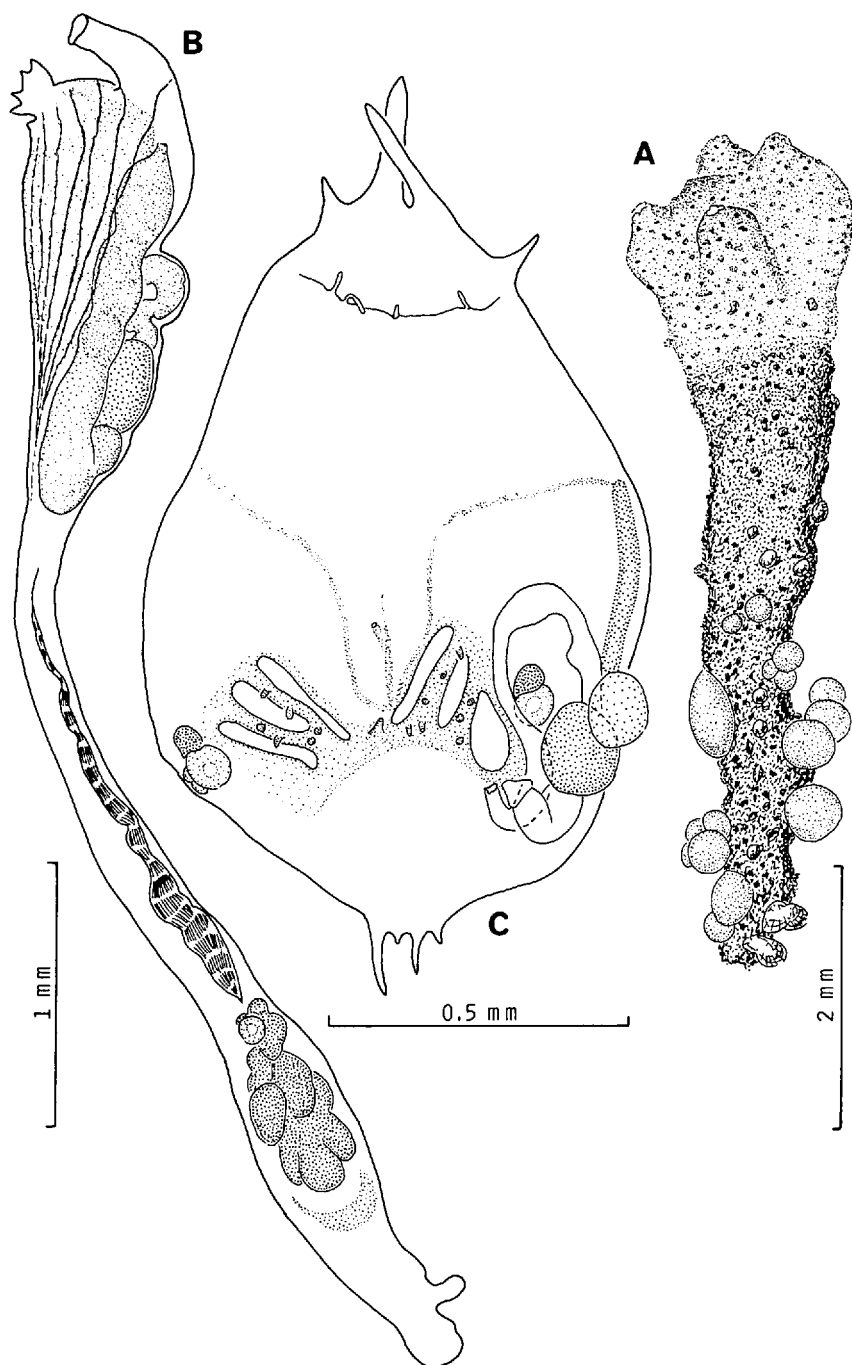


Figure 2. A, *Synoicum daucum* Monniot and Monniot, 1974, habitus; B, *Pseudodiazona abyssa* Monniot and Monniot, 1974, one zooid; C, *Minipera papillosa* Monniot and Monniot, 1974, internal side of the body cut along the ventral line.

The digestive tract is very short. The spherical stomach has only one rather indistinct longitudinal ridge on the ventral part and a small caecum. The intestinal loop is short; the posterior part of the intestine is enlarged even when the gut is empty (Fig. 3B). The lobated anus opens under the oesophagus near the cloacal aperture.

The body wall has a few, thin filaments around the cloacal aperture and there is a single large endocarp in the middle of each side of the body. There is only one polycarp on the right side, above the endocarp (Fig. 3B) and this has a short sperm duct.

Remarks.—This new species has a habitus different from the other four species of the genus *Bathystyeloides* in having only one long and strong rhizoid as a stem (excepting one specimen). The other described species can be differentiated as follows: (1) *B. enderbyanus* (Michaelson, 1904) is a large species (about 1 cm) living on all deep bottoms from 2,000 m to 6,000 m and characterized by one gonad on each side, numerous protostigmata and longitudinal bars. (2) *B. anfractus* Monniot and Monniot, 1985b is a small species (up to 3.5 mm) from the Indian Ocean near Mayotte. It is the shallowest *Bathystyeloides* (400 m–675 m). As in *B. enderbyanus*, there are numerous branchial longitudinal bars, about 40 on each side, one gonad on each side but longitudinal straight stigmata in a part of the branchial sac, on the right side, along the dorsal lamina. (3) *B. laubieri* Monniot and Monniot, 1974, redescribed in Monniot and Monniot, 1984a, has, in the branchial sac, some longitudinal stigmata on the dorsal part of the right side, two longitudinal bars on the right side and one only on the left. There is one polycarp on the right side only. This species was collected in the deepest depths of the northeast Atlantic basins, between 4,000 m and 5,000 m. (4) *B. dubius* Monniot and Monniot, 1984a, has been found only in the Bay of Biscay and the Madeira basin between 4,200 m and 5,200 m. Its branchial sac only contains protostigmata with two longitudinal bars on the right and one on the left side as in *B. laubieri*, but there is one gonad on each side. (5) *B. mexicanus* n. sp. differs from the other species in having at the same time only one gonad, undivided protostigmata and three longitudinal bars on each side in the branchial sac. It is known between 845 m and 144 m.

Family Pyuridae
Boltenia pilosa (Millar, 1955)

Station.—E2: 28°16.84'N, 86°14.67'W, 618 m, 1 specimen.

The species is recorded from the Gulf of Guinea, the Madeira basin and the Bay of Biscay between 4,700 m and 5,300 m (Monniot and Monniot, 1984a) and from the Indian Ocean near the Comoro islands in 615 m (Monniot and Monniot, 1985b). The specimen from the present collection is small: 2.5 × 2.2 mm. Its branchial sac is simpler than in the type specimen. We have pointed out (1985a) that the size of this species is very variable. It is not common and we do not have enough material to determine if taxonomic distinctions are suitable.

Family Molgulidae
Minipera papillosa Monniot and Monniot, 1974

Stations.—WC3: 27°37.56'N, 92°21.70'W, 750 m, 1 specimen; WC9: 27°41.53'N, 91°17.85'W, 761 m, 3 specimens in 2 cores; C4: 27°28.03'N, 89°47.08'W, 1,444 m, 1 specimen; C9: 27°29.22'N, 89°47.83'W, 1,390 m, 2 specimens.

M. papillosa is a cosmopolitan species known in the east Atlantic, west to the Azorean islands, in the Surinam basin, the Central Pacific and the Comoro basin from 2,800 m to 6,000 m. In the Gulf of Mexico it occurs much shallower, but the anatomical characters do not differ from those from deeper water. In one specimen of 0.5 mm diameter (Fig. 2C) with young gonads, we have seen only three protostigmata on each side and branchial papillae. This suggests that branchial development occurs at a similar rate in the shallow population to those in deeper water.

Minipera pedunculata Monniot and Monniot, 1974

Station.—E5: 28°00.4'N, 86°38.8'W, 2,853 m, 3 specimens in 3 cores.

This species is the smallest adult deep-sea ascidian, only 0.5 mm in diameter. It is recorded in the east Atlantic, the Surinam basin and the Comoro basin, between depths of 2,800 m and 5,300 m. It has been collected only in the deepest areas in the Gulf of Mexico.

Class SORBERACEA

Family Hexacrobylidae

Hexacrobylus indicus Oka, 1915

Synonymy.—*Hexacrobylus eunuchus* Monniot and Monniot, 1976a.

Stations.—E3: 28°15.80'N, 86°36.96'W, 847 m, 5 specimens in 3 cores; E5: 28°00.4'N, 85°38.8'W, 2,853 m, 2 specimens in 2 cores.

H. indicus is present in all oceans: Indian, Pacific and west Atlantic from the north of the Argentina basin, between 2,000 m and 5,500 m. It has been collected in shallower stations near the Comoro islands and very small specimens, from 300 m only, were doubtfully identified as this species as they were not mature. The Atlantic specimens of this species are always of small size contrary to those from the Indian Ocean where individuals of more than 1 cm exist. *H. indicus* is replaced in the eastern Atlantic by *H. arcticus* Hartmeyer, 1923, which is also known from 900 m and below in the Bay of Biscay.

General Characteristics of the Ascidian Collection.—The collections were made with a trawl or a box-corer. The latter gives quantitative results as deep-sea ascidians have a particularly small size. Each sample represents 475 cm² or 569 cm² and they have been repeated in each station. In this study we have pooled the specimens taken in the same station. The trawls are not efficient in catching animals of small size, the mesh being too large. Only one specimen (10.5 mm), *Bathystyeloides enderbyanus*, was caught in a trawl, but 128 specimens of 10 species were found in the cores.

In other regions of the world where ascidians were collected on deep bottoms with trawls and box-corers, the number of animals caught in trawls was larger than in cores. For example, in the Bay of Biscay, of 3,500 specimens taken with trawls, we found only 30 specimens in 150 box-cores; on the Demerara plain, we obtained 92 specimens in 15 trawls and six in 24 box-corers with a surface of ¼ m². This difference from the collections in the Gulf of Mexico indicates that the ascidian fauna is different from that of the western Atlantic, with the almost total absence of large species (i.e., size range from 5 mm to several cm).

Despite the shallower depths, all the species of the present collection are true abyssal forms known from abyssal plains. Only one species is a new one which belongs to a genus whose other representatives live in the deep sea. No ascidians

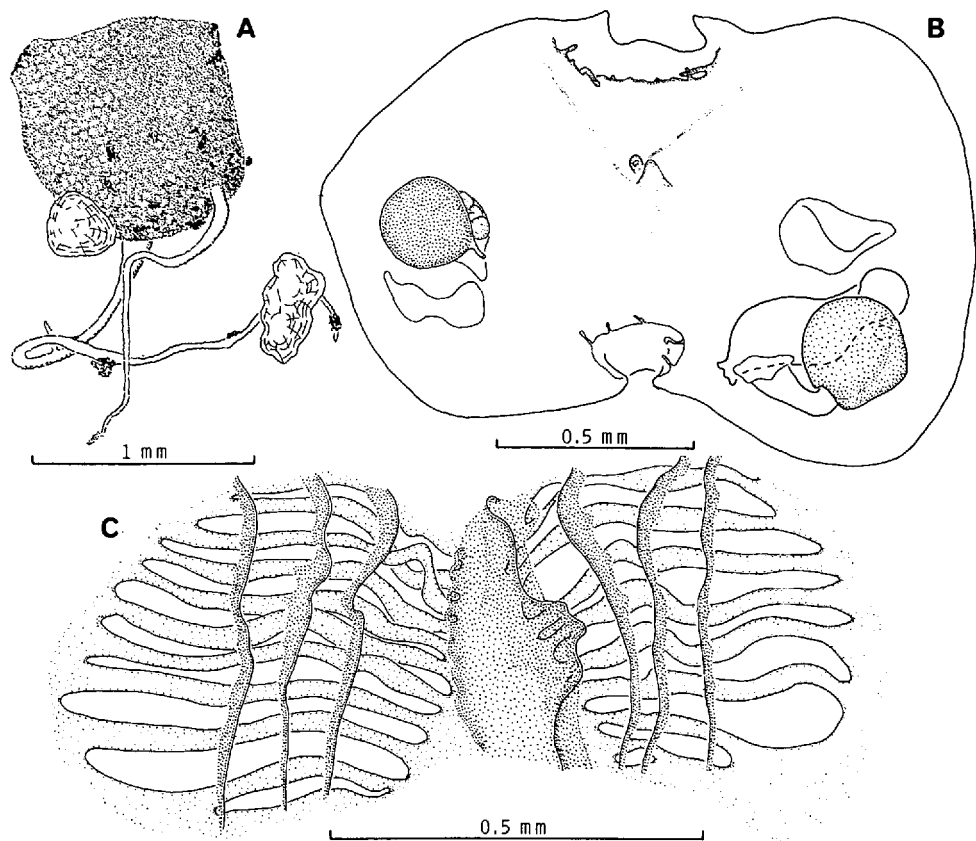


Figure 3. *Bathystyeloides mexicanus* n. sp.: A, habitus; B, internal side of the body, branchial sac removed; C, branchial sac.

were found in less than 500 m, and there is no relation between the fauna described here and the littoral ascidians of the Gulf of Mexico (personal observations).

Density of Ascidians on the Slope.—The high density of ascidians collected in the Gulf of Mexico is surprising, attaining a maximum of 37 individuals/m². This is not an exceptional value as all the stations “sampled enough” between 700 m and 1,400 m have densities equal to or greater than 8 specimens/m². This is a greater abundance than recorded elsewhere. In the Bay of Biscay the density is about one specimen/m² at the stations A and B (Sibuet et al., 1984). In the center of the Indian Ocean a maximum of three specimens/m² was observed (Monniot C., 1984). In the central North Pacific, Hessler and Jumars, 1974 found an average of 1.2 ascidian/m².

Species Diversity.—*Dicarpa simplex* Millar, 1955 is the most abundant ascidian in this fauna. This species is very abundant on the central transect between 800 m and 1,400 m and at 900 m on the eastern transect, with a maximum density of 32 individuals/m² in C4 at 1,400 m and 17 individuals/m² in E3 at 850 m. In the WC transect this species first appears at 550 m. It was not found below 2,000 m.

For other species the maximum diversity occurs on the central transect at about 1,400 m with five species. For the eastern stations, the maximum species diversity

is located between 600 m and 850 m, but at 1,400 m and 2,800 m important populations are present; the diversity there is smaller but the results are not really significant because the samples were less numerous; 5 and 11 box-cores instead of 33. The WC stations do not show a large diversity but they are not very different in depth. They indicate that the belt of *Dicarpa simplex* appearing in E and C transects extends in the western part of the Gulf of Mexico. The west transect, less prospected, has a much poorer ascidian fauna with only two *D. simplex* and one ascidian too young to be identified.

The ascidian fauna of the slope of the north part of the Gulf of Mexico differs from that of other deep bottoms in the world in having the maximum species diversity between 700 m and 1,400 m. Elsewhere we found a minimum diversity between 1,000 m and 2,000 m and a maximum between 4,000 m and 5,000 m (Monniot F., 1979). This is a significant difference as the minimum number of species was about 20 and the maximum more than 70 (Monniot and Monniot, 1978). It would be interesting to know the composition of the ascidian fauna deeper in the center of the basin of the Gulf of Mexico.

Bathymetric Distribution.—All the species present on the north slope of the Gulf of Mexico occur in shallower water than in other basins. Two species, *Synoicum daucum* and *Boltenia pilosa*, found above 1,000 m were previously known only below 4,000 m. We have said several times that below the permanent thermocline most of the species have a large bathymetric distribution and that the principal requirement for ascidians is the environmental stability more so than a given temperature. The distribution of the deep sea ascidians in areas where they are well known, as in the Atlantic, seems to be principally in relation to water masses. Along the northern slope of the Gulf of Mexico the water masses are divided into four main layers: the surface Gulf water, the tropical Atlantic central water, the Antarctic intermediate water and below 800 m, the Gulf deep water (annual Report of the Northern Gulf of Mexico Continental Slope Study, LGL Ecological Research Associates and Texas A&M University, May 1985). The majority of stations containing ascidians were located in the Gulf deep water mass which has considerable stability in physicochemical characteristics. The presence of a unique water mass below 800 m does not explain that the maximum abundance and species diversity of ascidians are located between 700 m and 1,400 m, and not below.

Origin of the Fauna of the Gulf of Mexico.—Although 1 species is new, the 10 other ascidians recorded all have wide distributions. All live in the South Atlantic and many in the basins bordering South America. The Antarctic current is probably responsible for the dispersal of ascidians and hydrological studies have made obvious the presence of a layer of Antarctic intermediate water between 500 m and about 1,000 m along the northern continental slope of the Gulf of Mexico (LGL 1985 annual report). So the deep fauna of ascidians are partly cosmopolitan and partly of a South Atlantic origin.

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